

## CLAIMS

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2  
3 1. A method of operating a filesystem, said filesystem including a live  
4 filesystem accessible to users and a zombie filesystem not accessible to users, said method  
5 including

6 recording changes to said zombie filesystem in a persistent memory.  
7

8 2. A method as in claim 1, including, for a deletion operation on a file  
9 in said live filesystem,

10 transferring said file from said live filesystem to said zombie filesystem;

11 breaking links associating disk blocks with said file in a plurality of steps  
12 while said file is associated with said zombie filesystem, wherein said recording of  
13 changes includes recording said breaking of links in a plurality of steps; and

14 altering said live filesystem to reflect said deletion operation.  
15

16 3. A method as in claim 1, including, for a truncation operation on a  
17 file in said live filesystem,

18 transferring at least a portion of said file from said live filesystem to said  
19 zombie filesystem;

20 breaking links associating disk blocks with said file in a plurality of steps  
21 while a portion of said file is associated with said zombie filesystem, wherein said record-  
22 ing of changes includes recording said breaking of links in a plurality of steps; and

1           altering said live filesystem to reflect changes associated with said breaking  
2 of links.

3  
4           4.       A method as in claim 1, including, for an operation apparent to users  
5 as substantially atomic, performing said operation in a plurality of steps using said zom-  
6 bie filesystem, wherein said recording changes is performed in said persistent memory for  
7 each of said plurality of steps.

8  
9           5.       A method as in claim 1, including, for an operation performed on a  
10 file having attached data elements, performing said operation using said zombie  
11 filesystem.

12  
13           6.       A method as in claim 1, including, for an operation performed using  
14 said zombie filesystem, altering a size of said zombie filesystem during performance of said  
15 operation.

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17           7.       A method as in claim 1, including, for an operation performed using  
18 said zombie filesystem, checkpointing said filesystem during performance of said opera-  
19 tion.

1           8.     A method as in claim 1, including recording changes to said live  
2     filesystem in said persistent memory, wherein records of changes to said live filesystem and  
3     of changes to said zombie filesystem are substantially interspersed.

4  
5           9.     A method as in claim 1, including replaying a set of said changes in  
6     response to said record.

7  
8           10.    A method as in claim 1, including replaying a set of said changes to  
9     said live filesystem and to said zombie filesystem, wherein replay of changes includes sub-  
10    stantial interspersed performance of changes to said live filesystem and to said zombie  
11    filesystem.

12  
13           11.    A method as in claim 1, including replaying a set of said changes in  
14    said record in response to a crash recovery by said filesystem.

15  
16           12.    A method as in claim 1, wherein said persistent memory includes a  
17    log of substantially all changes, within a selected time duration, to either said live  
18    filesystem or said zombie filesystem.

19  
20           13.    A method as in claim 1, wherein said persistent memory includes a  
21    log of substantially all changes, within a selected time duration, to said zombie filesystem.

1           14.    A method as in claim 1, wherein said recorded changes include a set  
2 of substantially atomic operations to said zombie filesystem.

3  
4           15.    A method of operating a filesystem, said filesystem including a live  
5 filesystem accessible to users and a zombie filesystem not accessible to users, said method  
6 including  
7 dynamically growing said zombie filesystem.

8  
9           16.    A method as in claim 15, including, for a deletion or truncation op-  
10 eration on a file in said live filesystem,  
11 allocating storage within said zombie filesystem for metadata associated with  
12 said file;  
13 performing said dynamic growth in response to failure of said allocation of  
14 storage;  
15 re-performing said allocation of storage after said dynamic growth; and  
16 transferring said file from said live filesystem to said zombie filesystem.

17  
18           17.    A method as in claim 15, wherein said dynamic growth occurs, for  
19 an operation performed using said zombie filesystem, during performance of said opera-  
20 tion.

1           18.    A method of operating a filesystem, said filesystem including a live  
2    filesystem accessible to users and a zombie filesystem not accessible to users, said method  
3    including

4           transfer of a file to said zombie filesystem before breakage of links to blocks  
5    in said file, in response to an operation on said file, said operation using said zombie  
6    filesystem.

7  
8           19.    A method as in claim 18, wherein, for a deletion operation on a file  
9    in said live filesystem,

10           said transfer includes

11           creating a link associating said file with said zombie filesystem; and

12           breaking a link associating said file with said live filesystem;

13           and said deletion operation includes

14           breaking links associating disk blocks with said file in a plurality of steps  
15    while said file is associated with said zombie filesystem, wherein said recording of  
16    changes includes recording said breaking of links in a plurality of steps; and

17           altering said live filesystem to reflect said deletion operation.

18  
19           20.    A method as in claim 18, wherein, for a truncation operation on a  
20    file in said live filesystem,

21           said transfer includes

1           creating a link associating at least a portion of said file with said zombie  
2    filespace; and  
3           breaking a link associating said portion with said file in said live filespace;  
4           and said truncation operation includes  
5           breaking links associating disk blocks with said file in a plurality of steps  
6    while a portion of said file is associated with said zombie filespace, wherein said record-  
7    ing of changes includes recording said breaking of links in a plurality of steps; and  
8           altering said live filespace to reflect changes associated with said breaking  
9    of links.

11           21.    A method of operating a filesystem, said filesystem including a live  
12    filespace accessible to users and a zombie filespace not accessible to users, said method  
13    including

14           transfer of a file to said zombie filespace before performing any substantial  
15    portion of an operation on said file, said operation using said zombie filespace.

17           22.    A method as in claim 21, wherein, for a deletion operation on a file  
18    in said live filespace,

19           said transfer includes

20           creating a link associating said file with said zombie filespace; and

21           breaking a link associating said file with said live filespace;

22           and said deletion operation includes

1           breaking links associating disk blocks with said file in a plurality of steps  
2   only while said file is associated with said zombie filesystem, wherein said recording of  
3   changes includes recording said breaking of links in a plurality of steps; and  
4           altering said live filesystem to reflect said deletion operation.

5  
6           23.   A method as in claim 21, wherein, for a truncation operation on a  
7   file in said live filesystem,

8           said transfer includes  
9           creating a link associating at least a portion of said file with said zombie  
10   filesystem; and

11           breaking a link associating said portion with said file in said live filesystem;  
12           and said truncation operation includes

13           breaking links associating disk blocks with said file in a plurality of steps  
14   only while a portion of said file is associated with said zombie filesystem, wherein said re-  
15   cording of changes includes recording said breaking of links in a plurality of steps; and

16           altering said live filesystem to reflect changes associated with said breaking  
17   of links.

18  
19           24.   A method of operating a filesystem, said filesystem including a live  
20   filesystem accessible to users and a zombie filesystem not accessible to users, said method  
21   including

22           replay of an operation on a file, said operation using said zombie filesystem.

1  
2           25.    A method as in claim 24, wherein said replay is responsive to a set  
3 of recorded changes in a persistent memory;  
4           and including, for a deletion operation on a file in said live filesystem,  
5           transferring said file from said live filesystem to said zombie filesystem, and  
6           recording said transfer in said persistent memory;  
7           breaking links associating disk blocks with said file in a plurality of steps  
8 while said file is associated with said zombie filesystem, and recording said breaking of  
9 links in said persistent memory in a plurality of steps; and  
10           altering said live filesystem to reflect said deletion operation, and recording  
11 said alteration in said persistent memory.

12  
13           26.    A method as in claim 24, wherein said replay is responsive to a set  
14 of recorded changes in a persistent memory;  
15           and including, for a truncation operation on a file in said live filesystem,  
16           transferring at least a portion of said file from said live filesystem to said  
17 zombie filesystem, and recording said transfer in said persistent memory;  
18           breaking links associating disk blocks with said file in a plurality of steps  
19 while a portion of said file is associated with said zombie filesystem, and recording said  
20 breaking of links in said persistent memory in a plurality of steps; and  
21           altering said live filesystem to reflect changes associated with said breaking  
22 of links, and recording said alteration in said persistent memory.



1  
2           27.    A method of operating a filesystem, said filesystem including a live  
3    filesystem accessible to users and a zombie filesystem not accessible to users, said method  
4    including  
5            replay of a set of filesystem operations, said operations including at least  
6    some operations using said live filesystem and at least some operations using said zombie  
7    filesystem.

8  
9           28.    A method as in claim 27, wherein said replay is responsive to a set  
10   of recorded changes in a persistent memory;

11                   and including, for a deletion operation on a file in said live filesystem,

12                   transferring said file from said live filesystem to said zombie filesystem, and  
13   recording said transfer in said persistent memory;

14                   breaking links associating disk blocks with said file in a plurality of steps  
15   while said file is associated with said zombie filesystem, and recording said breaking of  
16   links in said persistent memory in a plurality of steps; and

17                   altering said live filesystem to reflect said deletion operation, and recording  
18   said alteration in said persistent memory.

19  
20           29.    A method as in claim 27, wherein said replay is responsive to a set  
21   of recorded changes in a persistent memory;

22                   and including, for a truncation operation on a file in said live filesystem,

1           transferring at least a portion of said file from said live filesystem to said  
2   zombie filesystem, and recording said transfer in said persistent memory;  
3           breaking links associating disk blocks with said file in a plurality of steps  
4   while a portion of said file is associated with said zombie filesystem, and recording said  
5   breaking of links in said persistent memory in a plurality of steps; and  
6           altering said live filesystem to reflect changes associated with said breaking  
7   of links, and recording said alteration in said persistent memory.

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